THE FORMATION AND RETENTION OF ASSOCIATIONS AMONG THE INSANE

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CONTENTS

I. INTRODUCTION

The experiments upon which the present article is based fall into two parts, those performed with insane subjects and those with normal subjects. The experiments with the insane were conducted at the State Hospital for the Insane, at Mendota, Wisconsin,[1] and those with normal subjects in the Psychological Laboratory of the University of Wisconsin.

The problem arose from a consideration of current practice respecting the methods of examining the memory of patients in insane hospitals. The patient, for example, will be told distinctly three or four facts such as the name of a color, a date, and a street address, with the warning that after a certain length of time, say a half hour, he will be asked to recall them. If at the end of that time little or nothing is recalled, and if in addition the patient is unable to recall certain of his more important recent experiences such as took place on his way to the hospital, his memory is considered "poor for recent events." Superficially, of course, such appears to be the case; and a diagnosis based upon such findings by men skilled in their interpretation may possess reliability. Nevertheless, it is at once apparent that under the expression "poor memory for recent events" as here used, are grouped without distinction, two things which are psychologically very

[1] The experiments at Mendota were conducted under the auspices of the Wisconsin Psychiatric Institute, directed by Dr. Wm. D. Lorenz. Dr. Lorenz has kindly verified the case histories and diagnoses included in this report. It is also with pleasure that the writer expresses his thanks to Dr. Frank I. Drake, superintendent of the hospital, and to the medical staff for their active cooperation while the experiments were in progress.

different, and which may quite probably be expected to vary more or less independently of one another. One is the rate of formation of associations, and the other is the degree of retention of these associations, once they are formed. For example in the case under consideration, a patient might fail in the recall either because (a) the name of the color, the date, and the street address made a very slight impression upon his nervous system—perhaps through poor attention, or because (b) though normally registered the impression was very rapidly obliterated, or (c) perhaps because of (a) and (b) both working together.

It was with a view to determining if possible, which if any of the above possibilities were actually taking place in each of three common types of mental defect, and the relative amount of disturbance in each, as indicated by the performance of normals under exactly similar conditions, that the present experiments were chiefly instituted. Incidentally, some interesting evidence was secured concerning fluctuations at the threshold of recall, which will be discussed in some detail in section V of this article.

II. Subjects

In all, nineteen subjects were used in the experiment, nine insane and ten normals. The latter were summer session students at the University of Wisconsin. The insane group consisted of three constitutional inferiors, three dementia praecox, and three paretics; they were very carefully selected from a group of over eighty patients who had previously been experimented on at some length, in an effort to adapt the Binet-Simon tests to the determination of the extent of intellectual degeneration among the insane. They were chosen on a basis of being tractable under experimental conditions, of being relatively clear types of their respective diseases, and of being at about the same intellectual level as shown by the very careful mental tests to which they had all been subjected. The intellectual level chosen was roughly, the ability to pass from thirty-five to forty of the Binet tests (Goddard's revision). Upon trial, however, it was found impossible for paretics of this grade of intelligence to learn the rather difficult material used, so a new group of paretics, of an intellectual ability sufficient to pass from forty-five to fifty tests[2] had to be substituted.

[2] Fifty-one was found to be the median number of tests passed by normal adults of about the same age and station in life. The so-called "wide-range" method of testing was employed.

The following brief case histories of the nine patients were compiled from the clinical records of the hospital, with special reference to memory:

Bur. Male, age 26. Constitutional inferiority with criminal episodes. He attended school for three years but learned little. After his fifteenth year he drank occasionally. He once threatened suicide to scare his father. He had stolen several bicycles and broken into a creamery. When admitted to the hospital he talked freely and relevantly regarding his misdeeds. Later he ran away from the hospital several times. Upon one occasion having been arrested, he set fire to his cell in the jail. His memory appeared normal.

Sch. Male, age 42. Constitutional inferiority with episodes of excitement and depression. He attended district school where he was considered far below the average. Previous to admission he had attacks of depression during which he threatened suicide. In one of them he attacked his wife with a knife. He said that something like a voice told him to do it. During his hospital residence he showed childlike docility though periods of depression continued to appear. His memory was good.

Syg. Female, age 16. Constitutional inferiority with episodes of excitement. She attended school eight years but was below normal in her work. Before admission she was frightened by a drunken attack upon her father and for two weeks showed disturbance and fear. Some months later she became disturbed again and expressed fear of personal injury. During her hospital residence she showed periods of indifference alternating with flighty, mischievous periods.

Don. Male, age 22. Dementia praecox, hebephrenic form. About a year before the experiment he began to visit neighbors and interfere with their work. He became at times incoherent and rambling in his speech. He thought a gang was after him. Upon admission to the hospital he showed no insight into his condition. During his residence he was quiet and orderly.

Jack. Male, age 36. Dementia praecox, simple deteriorating type. Attended agricultural college one year. Upon admission to the hospital he was quiet and orderly. He answered questions irrelevantly and was inclined to mutter. His movements were sluggish and he showed no interest in his surroundings. He seemed to be perfectly contented. His memory was good.

Jaco. Male, age 24. Dementia praecox. He attended common school but was not considered especially bright.

Before admission he thought that there was something queer about him and read the Bible to find out about it. There he found passages referring to him. Just before admission he attempted suicide. Upon admission he was alert and pleasant. He laughed while explaining that he sometimes thinks that his father is Jesus and that he himself is the devil.

Har. Male, age 38. Paresis, cerebral form, mildly expansive type. About two years before the experiment he became very forgetful. He would leave his grip or an auto which he had hired and forget all about them. He thought that he was about to receive enormous profits from some investments. Upon admission his pupils were unequal; they showed sluggish reaction to light and prompt reaction to accommodation. He showed a slight Rhomberg, very active deep reflexes, and tremor of extended fingers, of facial muscles, and of tongue. There was also marked speech defect. Both blood and spinal fluid gave positive Wassermann reactions. He showed mild euphoria and a somewhat faulty memory for recent events.

Sau. Male, age 40. Paresis, cerebral form, demented type. About four years previously he began to drink excessively and to keep loose company shamelessly. Upon admission to the hospital his pupils were unequal and they did not react to light or accommodation. He showed very active deep reflexes, marked tremor of tongue and fingers, slight speech defect, and irregular writing. He gave a positive Wassermann reaction to both blood and spinal fluid. He showed a lack of interest in the examination. Later he had the idea that he was to marry W. J. Bryan's daughter. His memory for recent events seemed to be good.

Ev. Male, age 47. Paresis, tabetic form, expansive type. About two years before the experiment he began to talk about schemes to make large amounts of money. Upon admission his pupils were equal but irregular and of the Argyll-Robertson type. His knee jerks were absent and he showed slight speech defect and tremulous writing. Both blood and spinal fluid gave a positive Wassermann reaction. He showed pronounced euphoria and delusions of grandeur. His memory for recent events was poor.

The patients had become accustomed to examinations through those ordinarily given by the hospital physicians and through presentations at staff meetings. They had all been put through the Binet tests which also gave them some familiarity with the experimenter. He frequently met them in the wards and in general cultivated friendly relations with them.

All appeared to have a friendly attitude toward him; and, with a single exception to be noted later, all co-operated very willingly throughout the experiment and showed a distinct interest in the progress of the learning.

The normal subjects consisted of two men and eight women. They were volunteers from a class in introductory psychology.

III. Procedure

The experiments with the insane were conducted in an ordinary patient's room on one of the quietest wards of the hospital. It was believed that such familiar surroundings would be less disturbing to the patients than a special experimental room.

The experiments with the normals were performed in a small room adjoining the main psychological laboratory, at the University of Wisconsin, the size, lighting, etc., being very similar to those at the hospital. The material to be associated, the apparatus and the general technique were identical for both groups of subjects except in a few cases where rest periods had to be permitted to the insane.

Briefly, the plan of the experiment was to have the various subjects form associations to a certain known degree of perfection. The time consumed served as a measure of the rate at which associations were formed. After a week had elapsed they were tested on these associations. The number of associations correctly recalled, together with the number of promptings required for re-learning served as independent measures of the retention. The material consisted of twelve Chinese characters with twelve nonsense syllables (spoken) one of which was associated with each character. The characters were drawn in ink on cards three-quarters of an inch wide which were placed in holders on a drum. This drum revolved step-wise before a small window.[3] The revolutions were controlled by clockwork within the apparatus which was so adjusted that the exposures were of exactly five seconds duration. A character was thus stationary during practically its entire exposure, being suddenly replaced by the next character in the series at the end of the five-second period. The ticking of the clockwork was slow and very quiet, about like an ordinary clock. The subject sat in a comfortable chair before the apparatus, his eyes about on a level with the exposure window, and his back to the window of the room. The

[3] An imperfect model of this apparatus was demonstrated at the Chicago meeting of the Psychological Association in 1915.

experimenter sat on a high stool at the side of the apparatus, facing the subject.

The names of the characters were taught to the subjects by a prompting method. The experimenter called out their names distinctly at the middle of each exposure as indicated by the ticking of the clockwork. The subject repeated the name each time he was prompted. An exact record of the subject's performance was made upon a special blank as the experiment proceeded, a minus sign being recorded each time the subject required prompting, a plus sign where he was able to respond correctly without being prompted, and in cases where an incorrect response was given, he was corrected and the nature of the error recorded. Thus was secured a very complete record of the process of forming the associations. A typical record by a normal subject (No. 7) is shown in table No. III. The incorrect responses are replaced by minus signs.

The learning was continued without interruption until the subject was able to reproduce consecutively the names of the entire list of twelve characters once without prompting. Then the characters were arranged on the drum in a different order and the learning was continued as before until the subject was able to reproduce the series twice in succession without error. At the beginning, subjects were cautioned not to learn the names of the characters in series and the learning of the second order of characters was introduced to secure this more effectually.

Exactly a week after the completion of the learning, each subject was confronted by the characters again in the second (final) order learned, and he was given two opportunities to name each character, i. e., through two revolutions of the drum. At the third revolution the prompting was resumed as before and continued without interruption until the learning had reached exactly the perfection attained the week before, i. e. two successive perfect reproductions.

During the forgetting period of one week, the insane subjects had no reason to expect that they would be called on to reproduce the material learned. It was necessary, however, to tell the normals to return the following week " for another short experiment " which caused a number of them to wonder if they would be asked to recall what had been learned. But all denied consciously rehearsing any of it to themselves.

IV. Results and Conclusions Respecting Memory

The results of the experiments concerning the formation and retention of associations are shown in Tables I and II, for the insane and the normals respectively. A comparison of these two tables reveals two rather striking features which furnish at least tentative answers to the questions with which we set out.

1. It took, on the average, 102 minutes for the insane to form associations which required on the average only 26 minutes for the normals. Thus the insane as a group show a very great disturbance of the ability to receive impressions, requiring on the average about four times as long as normals. Of the disease groups, the three dementia praecox patients make the three best scores, the three constitutional inferiors average next best, and the three paretics average the worst of all.

TABLE I

Showing for the insane subjects the number of Binet tests passed, the number of minutes required to form the associations, and the amount forgotten after one week.

		Intelligence	Minutes required to form associations			Amount forgotten after one week	
Disease	Subject	No. of Binet tests passed	First order	Second order	Total	No. of characters not recalled	No. of promptings to relearn
Constitutional Inferiors	*Bur.*	37	75	14	89	2.0	0
	Sch.	38	124	46	170	4.5	27
	Syg.	35	51	21	72	5.5	26
Dementia Precox	*Don.*	37.5	36	9	45	7.0	21
	Jack.	40	46	6	52	5.0	19
	vaco.	47.5	29	10	39	1.0	0
Paretics	*Har.*	48	170	30	200	4.0	18
	Sau.	50	45	105	150	2.0	10
	*Ev.**	44	95*	45*	140*	11.3*	258*
Average			72	30	102	3.9	15
M. V.			38	22.6	53	1.6	8.9

* The results of subject *Ev.* are not included in the final averages for reasons given on page 426.

2. In marked contrast to the great disturbance in the formation of associations among the insane, we find that once the associations get formed, they are retained practically as well as by normals. In fact the insane patients are able actually

to recall on the average more of the names of the characters at the end of a week than were the normals, averaging 3.9 failures against 4.7 failures by the normals. But when it comes to the labor of relearning, as might be expected from their more rapid learning in the first place, the normals recover their really greater loss in a shorter time, requiring only an average of nine promptings against fifteen for the insane.

The results of the present study accordingly seem to indicate that at least with samples of the three types of mental disease here investigated, the memory disturbance is primarily one of registration rather than of retention. Their memory for recent events is probably normal if the experience succeeds in making a normal impression.

TABLE II

Showing for the normal subjects the number of minutes required to form the associations, and the amount forgotten after one week.

	Minutes required to form association			Amount forgotten after one week	
Subject	First order	Second order	Total	Number of characters not recalled	Total number of promptings to relearn
1. *Bic*.....	17	6	23	4.0	6
2. *Mc*.....	14	8	22	6.5	24
3. *Bir*.....	16	9	25	6.0	12
4. *Fi*.....	12	8	20	4.5	1.5
5. *La*.....	39	7	46	4.5	12
6. *Ha*.....	19	8	27	2.0	3
7. *Ho*.....	19	4	23	3.5	4
8. *Os*.....	17	11	28	4.5	7
9. *Fr*.....	16	9	25	6.5	12
10. *Pi*.....	18	5	23	5.0	14
Average.....	18.6	7.6	26.2	4.7	9.4
M. V.....	4.1	1.6	3.5	1.0	5.25

Two or three details and possible qualifications need to be considered at this point. It will be recalled that in Table I, the results of one subject, (*Ev.*) a paretic, while tabulated with the rest, are not included in the averages. The learning series of this subject was completed successfully, but he strenuously objected to returning a week later to finish the experiment and only went at the emphatic command of the orderly. During the experiment he was sullen, complained of being seriously ill, and obviously made slight effort. He recognized only one of the twelve characters on the test and

consumed 84 minutes in the relearning, requiring over 250 separate promptings in all. His case furnishes a striking contrast to the other abnormals who average only fifteen promptings.

The interpretation of the results in his case are consequently exceedingly doubtful. It is well to remember that this patient had degenerated in intelligence until he was able to pass only 44 of the tests, against a score of 48 and 50 respectively for the other two paretics who showed normal retention. It may also be recalled that a paretic of only a little lower mentality could not learn the material at all. Possibly the retentiveness of paretics becomes disturbed some time after the impressibility has been shattered. It is interesting to note also that this patient had charge of the laundry of his ward and was fairly efficient. On the other hand the paretic *Har.* would very commonly return from an errand to some other part of the building to ask what he had been sent after, having forgotten the errand while on his way to do it. Yet *Har.* gives a smaller record of forgetting than the average normal. The writer inclines to attribute the large score of *Ev.* to possible illness and certain opposition.

The question also arises as to why the insane (with the exception noted above) showed an actually better average score for retention than the normals. In the first place the difference is not great and may have no significance in view of the considerable variation among the insane. The relatively quiet life of the insane might have favored it though all but one of them (*Sau*) performed regular work at the hospital. The long learning periods as such, could scarcely have caused it as it has been repeatedly shown that subjects who take a long time to learn on the whole tend to retain somewhat less than those who learn rapidly.[4]

The most probable explanation seems to lie in the fact that the learning activity produces fatigue which inhibits the power of recall to a certain extent,[5] especially at the end of a protracted learning period. This necessitates a somewhat better learning to produce the required score at the end of a long learning series than at the end of a short one. This may very probably account for the slightly better retention of the insane than of the normals. The experimenter was careful, however, to allow occasional rest periods in the more protracted cases of learning—in two cases rather long one.

[4] D. O. Lyon, "The Relation of Quickness of Learning to Retentiveness", *Archives of Psychology*, No. 34.

[5] E. L. Thorndike, *Educational Psychology*, II., pp. 300ff.

For example, the paretic *Sau,* had a rest period at one time of twenty hours and it is interesting to note that he was able to name correctly more characters after this wait than when he terminated the learning process. During the four minutes preceding the rest he made the following successes: 7, 6, 5, 5; and the first four minutes after resumption: 8, 7, 8, 6. Likewise the other case (*Har.* also a paretic) made an average score of five successes before the rest and of six and one-half successes immediately after resumption.

It is also well known that relearned material is more durable than that only once learned. But this factor must have been slight as the amount forgotten was in each case small, often imperceptible.

V. Fluctuations at the Threshold of Recall

Before the experiment had progressed very far, another marked difference was noticed between the performance of the insane and the normals. This was the greater prevalence among the insane of what may be called "fluctuations at the threshold." What is meant by this may be most easily understood by exhibiting a concrete case (Table III) where the phenomenon appears in a typical form. This is the record of the original learning (first order) of normal subject number seven.

TABLE III

Showing a typical learning record by a normal subject (No. 7).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
nä 1	−	+	−	−	−	−	−	+	−	−	+	−	+	+	−	−	+	+	+
00 2	−	−	−	−	−	−	−	−	−	−	+	−	−	−	+	−	+	+	+
vŏ 3	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	+	+	+	+
hui 4	−	−	−	−	−	−	−	−	−	−	−	+	−	−	+	−	+	−	+
ling 5	−	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
fĭd 6	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
tä 7	−	−	−	−	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+
le 8	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+
deg 9	−	−	−	−	−	−	−	+	+	+	+	+	+	−	+	+	+	+	+
yer 10	−	+	−	−	−	−	−	−	−	+	+	−	+	+	+	+	−	+	+
nĕz 11	−	−	−	−	−	+	+	+	−	+	+	+	+	+	+	+	+	+	+
chun 12	−	−	−	+	−	+	+	+	−	+	+	+	+	+	+	+	+	+	+

It will be seen at once from this record that frequently a subject will be prompted several times on an association after which he succeeds on it. But after one or two more trials, success will be followed by failure and this in turn

by success and this again perhaps by failure and so on. By the term fluctuation is understood one or more consecutive successes (plus signs) followed by one or more consecutive failures (minus signs). Thus the record of the formation of the first association shown in Table III (*Na*) has four fluctuations—an unusually large number. The first fluctuation begins with trial 2 and ends with trial 7, the second with trial 8 and ends with trial 10. The third fluctuation begins with trial 11 and ends with trial 12, while the last one begins with trial 13 and ends with trial 16.

Now it will be shown later that in order to make a valid comparison of the records of the normals and the insane in this respect, it will be necessary to know more exactly the nature of the phenomenon under consideration. Superficially, at least, the fluctuation appears to be the result of some sort of wave activity (perhaps related to the attention) which is crossing the threshold. Assuming temporarily that this is the case, we shall proceed to examine in some detail the consequences which might be expected to result. Then we shall examine our experimental results to see how far these *a priori* expectations are justified. And lastly if the correspondence is sufficiently exact to warrant, we shall proceed to the comparison of the records of the abnormals with those of the normals upon this basis.

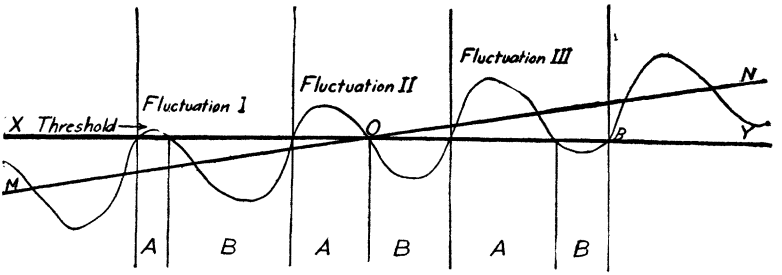

FIG. 1

Accordingly in Figure I let the straight line XY represent the threshold of recall; and let the undulating line MN represent any fluctuating process crossing it at a moderate angle. Then obviously, certain things will be likely to follow:

1. The process would be found to alternate above and below the threshold one or more times.

2. In the first fluctuation of a series of two or more fluctuations, the time above the threshold (A) will be shorter than the time below it (B).

3. In the last fluctuation of a series of two or more fluctuations, the time below the threshold (B) will be shorter than the time above it (A).

4. In the middle fluctuation of a series of three or more fluctuations, the time above the threshold (A) will be approximately equal to the time below it (B).

5. If the waves are regular and uniform throughout, the average duration of all complete fluctuations will be approximately equal in whatever position they occur.

6. If, on the contrary, the size of the waves vary considerably from moment to moment, the shorter waves (with presumably shorter period) will tend to intersect the threshold only in the intermediate fluctuation rather than the first or last, thus making the average total duration of the middle fluctuation of a series of three or more, less than that of either extreme.

7. If the direction of the propagation of the wave process should itself curve towards the horizontal so as to make a more acute angle with the threshold as it rises above the latter, (as is usually assumed to be the case in learning) then the last fluctuation would tend to be of slightly longer duration than the first.

8. The more acute the angle at which the wave process crosses the threshold, the height and period of the wave remaining constant,

A. The greater will be the total number of fluctuations at each crossing.

B. The greater will be the length of time between the first appearance above the threshold to the last disappearance below it, i. e., the greater will be the temporal fluctuation span.

C. The longer will be the time required to mount permanently above the threshold.

9. The taller the waves, their period and the angle at which their direction of propagation crosses the threshold remaining constant,

A. The greater will be the total number of fluctuations at each crossing.

B. The greater will be the temporal fluctuation span.

C. The longer will be the time required to mount permanently above the threshold.[6]

[6] The exact similarity of the results which follow from conditions (8) and (9) will doubtless be noted. This does not mean, however, that the influences of the two factors are indistinguishable from one another. Theoretically at least it is a relatively simple matter to determine for example, how much of the total time consumed in rising per-

We proceed next to see how far our principles developed by *a priori* reasoning are justified by the experimental data. Only two possible cases are open to us. One is to secure the central tendency of the duration of the respective phases of all cases of individual associating processes of two complete fluctuations. The second case is to do the same for all cases of three complete fluctuations. The number of cases of four fluctuations among the normals is too few to possess any reliability, and the extreme variability of the abnormals makes results obtained from them of slight value.

Forty-three cases of double fluctuation were discovered in the records of the ten normal subjects of this experiment, together with the records of twenty other normals who had learned the same material and in the same way but for a different purpose. When added together the total number of successes and failures of the respective phases of each of the two fluctuations are as follows:

Fluctuation I		Fluctuation II	
+	−	+	−
71	88	76	52
159		128	

The totals of fluctuation I clearly accord with principle two, and those of fluctuation II accord completely with principle three. The total time of fluctuation I is distinctly larger than that of fluctuation II, which contradicts principle seven.

We now proceed to the cases of triple fluctuation. In all the thirty odd normal records available for this purpose, only eleven cases of triple fluctuation were found. They are assembled in Table IV and here again the totals will be considered instead of averages.

As before, the relative sizes of the two totals of fluctuation I confirms principle two. Likewise those of the last fluctuation (III) reconfirm principle three. The two totals of fluctuation II while not the same are nearer alike than those of

manently above the threshold was consumed by natural slowness of learning and how much by the fluctuation. In Figure I the entire time consumed in rising permanently above the threshold is XB. If there had been no fluctuations, the threshold would have been crossed for the first and only time at O. Therefore the distance OB is due to the fluctuation and the remainder, XO is due to the natural slowness of learning.

Accordingly, in a given fluctuation record, the part of the apparent learning time consumed by the fluctuation activity ought to be one half of the fluctuation span. If this hypothesis be essentially correct, then this time is really spent in over learning.

either extreme and suggest a confirmation of principle four. The total duration of fluctuation II is less than that of either the first or last fluctuation confirming principle six and tending to reject alternative principle five. Lastly the total duration of fluctuation III is greater than that of fluctuation I thus suggesting confirmation of principle seven.

The coincidences of the experimental results with those of the theoretical analysis while not exact, are nevertheless, very striking. Principles 1, 2, and 3, seem to be amply substantiated; and number 4 also, but with less certainty. Number 6 is confirmed rather than its alternative, number 5, which is what one would expect in a field where practically everything else is subject to variation. The evidence regarding number 7 is conflicting.

Much of the confirmation has necessarily come from the triple fluctuation series which, unfortunately, contains only eleven cases, and naturally its reliability is small. The apparent confirmation may be due to chance, but it is at least interesting to note that if we take separately the totals of

TABLE IV

	Fluctuation I		Fluctuation II		Fluctuation III	
	+	−	+	−	+	−
	1	2	1	1	1	1
	1	2	1	4	1	1
	1	1	2	1	1	2
	1	1	1	1	1	3
	1	2	1	1	1	1
	2	3	1	1	5	1
	1	2	1	1	2	2
	1	2	2	1	2	1
	3	2	1	1	1	1
	1	2	1	2	4	2
	1	1	1	2	3	1
Total	14	20	13	16	22	16
	34		29		38	

either of the two groups of subjects from which they come, all of the significant tendencies appear in each, exactly as when combined. Thus the normals properly of this experiment are:

Fluctuation I		Fluctuation II		Fluctuation III	
+	−	+	−	+	−
7	11	7	9	10	9
18		16		19	

and the subjects from the other experiment:

I		II		III	
+	−	+	−	+	−
7	9	6	7	12	7
16		13		19	

Having disposed of the preliminary theoretical considerations, we may now proceed to a comparison of the relative amounts of fluctuation at the threshold found in the normals and abnormals respectively, according to the principles thus rendered probable. As previously indicated, the insane showed vastly more fluctuations than the normals. But it is obvious from the principles worked out above, notably number 8, that we cannot safely take the gross amounts of fluctuation at face value. On the contrary, if it takes one group of individuals four times as long to cross the threshold as another group, then we must expect that the former group would normally show four times as wide a span of fluctuation, assuming the wave activity to be otherwise identical in the two groups. Clearly then in order to compare the normals with the abnormals in this respect, we must divide the fluctuation span of the latter by 4. If after this the fluctuation span of the insane is still twice as great as that of the normals (as it turns out in fact to be) then we may with considerable certainty conclude (according to principle 9B) that the height (or depth) of the wave among the insane, is approximately twice that of the normals.

TABLE V

Showing the index of the fluctuation span and the index of the number of fluctuations for the insane subjects.

Disease	Subject	Index of fluctuation span	Index of number of fluctuations
Inferiors	*Bur*	4.0	.9
	Sch	2.0	.11
	Syg	5.0	.84
Precox	*Don*	2.plus	.55
	Jack	2.4	.35
	Jaco	3.0	.72
Paretics	*Har*	5.7	.63
	Sau	3.2	.6
	Ev	6.2	.89
Average		3.7	.7
M. V.		1.1	.2

As a matter of fact the technique actually utilized was somewhat more refined than that described above, though based upon the same principle. An index of the fluctuation span was computed for each subject by adding all the fluctuation spans found in each subject's record and dividing the total by the number of minutes required by that subject to complete his first learning. A corresponding index of the *number* of fluctuations was also calculated for each subject per unit time. These are shown for the abnormals and the normals in Tables V and VI respectively.

TABLE VI

Showing the index of the fluctuation span and the index of the number of fluctuations for the normal subjects.

Subject	Index of fluctuation span	Index of number of fluctuations
1. *Bic*	2.6	1.0
2. *Mc*	1.0	.5
3. *Bir*	2.25	.8
4. *Fi*	2.2	.6
5. *La*	1.8	.5
6. *Ha*	.8	.3
7. *Ho*	2.3	.8
8. *Os*	1.9	.5
9. *Fr*	2.25	.6
10. *Pi*	1.6	.4
Average	1.87	.6
M. V	.46	.16

A comparison of these tables shows that after the fluctuations of the two types of subjects have been reduced to a common basis:

1. The number of fluctuations at each crossing is about the same with the insane as with the normals, the average being respectively .7 and .6. The larger figure with the insane has slight significance in view of the large M. V.

2. The average span of fluctuation (from the first success to the last failure) is almost exactly twice as much for the insane as for the normals being 3.7 for the former and only 1.87 for the latter. This evidently means (principle 9) that the "height" of the individual fluctuations (i. e. the average differences between the crest and the trough of the fluctuation) is approximately twice as great among the insane as among the normals.

VI. Summary

1. The power of forming associations is greatly impaired in constitutional inferiors, demential praecox and paretics.

2. This power is far more seriously impaired in paretics of a given degree of dementia than in the other two types of corresponding degree of dementia.

3. The retentiveness of the three types of insane subjects seems to be entirely undisturbed.

4. The fluctuations which occur at the threshold of recall during the process of forming associations appear on the average to follow very closely the law of an irregularly undulating wave crossing a line, the direction of the propagation of the wave perhaps being that of the conventional curve of learning.

5. Having reduced the respective fluctuation records according to this principle, it is found that the number of fluctuation at each crossing appears to be about the same for the insane as for the normals.

6. It is further found that the fluctuation span of the insane is about twice as great as that of the normals. This indicates that the fluctuation waves of the insane are on the average about twice as profound as those of the normals.